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# OBSERVATIONS ON THE IMPACT OF WESTERN SPRUCE BUDWORM IN THE VALLEY CREEK DRAINAGE, FLATHEAD INDIAN RESERVATION, MONTANA

by

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## ABSTRACT

The western spruce budworm, *Choristoneura occidentalis* (Free.), has caused a measurable impact on a portion of the Flathead Indian Reservation during a 5-year infestation period. This survey showed that most of the grand fir and alpine fir, and 13.8 percent of the Douglas-fir has been top killed in the Valley Creek area west of Arlee, Montana. The survey also disclosed that a total net growth loss of 19.6± 1.9 board feet per acre per year has occurred since 1967. Significant growth reduction at the 99 percent level occurred in Douglas-fir, grand fir, alpine fir, and western larch. Little mortality in trees 5 inches d.b.h. and greater has occurred to date. Of the trees under 5 inches d.b.h. 55.6 percent were not suitable for Christmas tree production because of insect damage.

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## INTRODUCTION

The Flathead Indian Reservation has experienced a western spruce budworm, *Choristoneura occidentalis* (Free.), infestation since 1967. Aerial surveys in 1972 show 195,000 acres of visible defoliation on the reservation (fig. 1). Resource managers are concerned about the damage that has occurred and what species has sustained the greatest impact in both visible top kill and actual growth loss.

The fact that western spruce budworm can cause extensive damage has been documented by several other workers. Williams (1966, 1967) found that radial growth reduction was most severe in the true firs, compared to Douglas-fir and spruce. Fellin and Schmidt (1967) reported that larch terminals were damaged by budworm feeding.

It was quite evident that the western spruce budworm had caused considerable damage to some stands on the reservation, as many areas displayed evidence of repeated defoliation. This evaluation was designed to measure both the visible damage, such as branch dieback and top kill, and actual growth loss expressed in terms of board and cubic feet.

## METHODS

A variable plot cruise was conducted to estimate the amount of visible damage to a 306-acre stand located west of Arlee, Montana, in the Valley Creek drainage. Standard cruise techniques were used to estimate tree volumes and trees per acre. Each tree 5 inches d.b.h. and larger within the 15 BAF variable plot was classified into one of seven damage classes and recorded on the cut or leave column of the timber cruise data sheet. In addition twenty-six 1/100-acre fixed plots were taken to obtain damage to Douglas-fir suitable for Christmas tree production. Only Douglas-fir trees within the 1/100-acre plot were also classified into damage classes. The seven damage classes are described as follows:

| Severity code | Damage class |
|---|---|
| 0 | Green (not defoliated) |
| 1 | Defoliated by western spruce budworm |
| 2 | Top kill less than 10 percent of live crown |
| 3 | Top kill greater than 10 percent but less than 30 percent. |
| 4 | Top kill greater than 30 percent but less than 50 percent. |
| 5 | Top kill greater than 50 percent |
| 6 | Mortality caused by budworm |

Variable plots were established on a 5- by 10-chain grid.

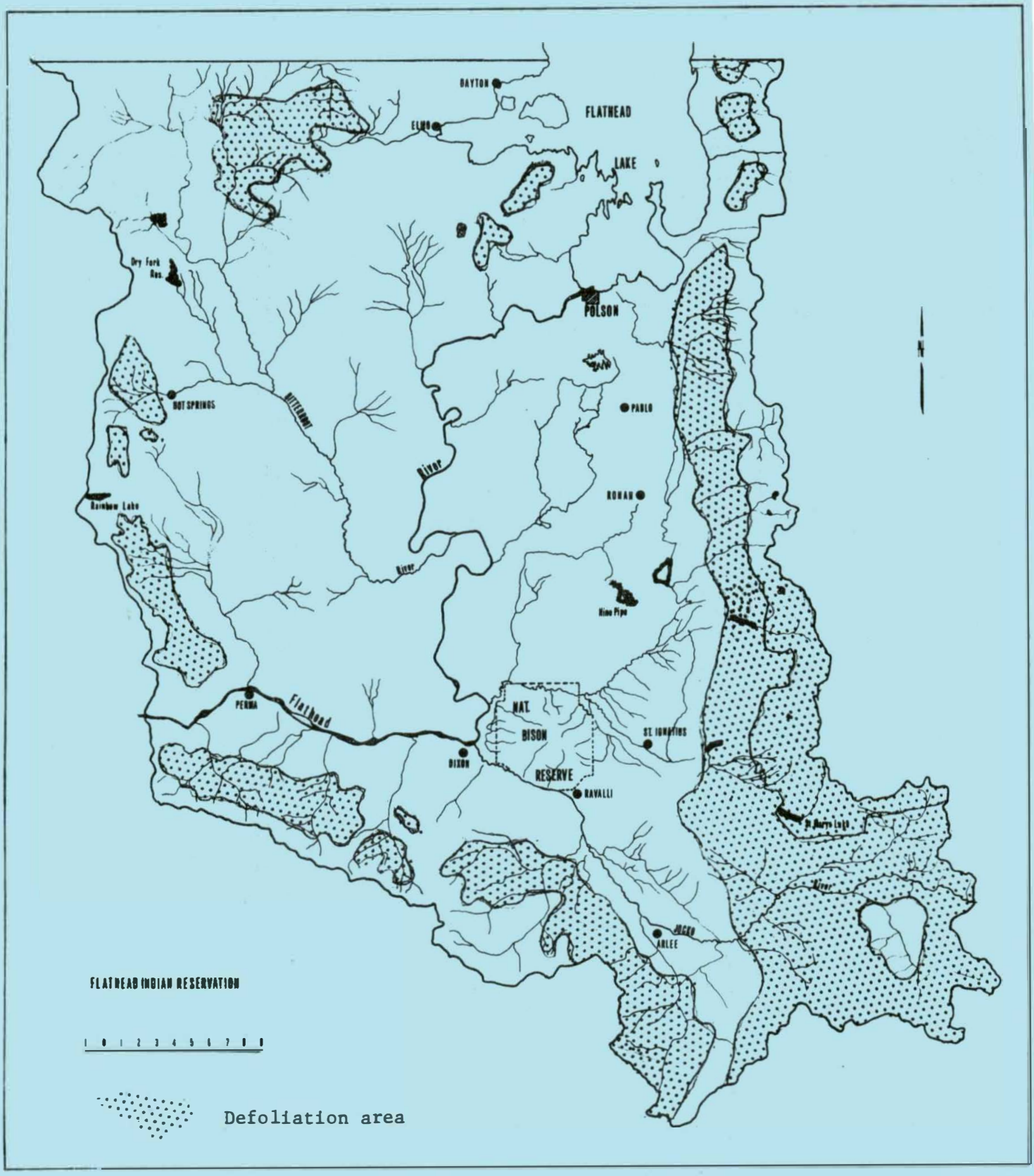


Figure 1.--Aerially visible defoliation on the Flathead Indian Reservation, 1972.

Information on growth loss was obtained by randomly selecting 18 of the 76 variable plots and a 1/10-acre fixed plot was superimposed over the variable plot. Diameters to the nearest one-tenth of an inch were taken on trees 5 inches d.b.h. and larger, and height to the nearest foot was recorded. From each of these trees an increment core was obtained from all trees on the plot which included the past 15-year growth history. All trees regardless of species were treated alike. The increment cores were placed in straws and identified as to tree and plot. Before desiccation occurred increment cores were examined under a binocular scope, and the past 15 years' growth was recorded in 5-year increments to the nearest hundredth of an inch. A total of 343 cores was included in the data base (fig. 2).

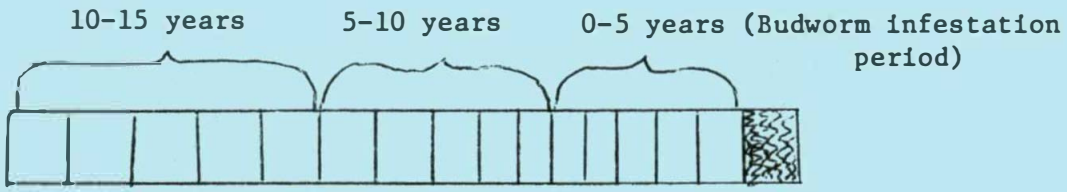


Figure 2.--Radial increment core showing growth periods compared for impact analysis.

Growth data prior to budworm infestation from the nonhost species, ponderosa pine and lodgepole pine, were used to develop multiple regression formulas to predict normal 0- to 5-year growth.

The following formula was used to predict radial growth for 0 to 5 years:

$$Y = -.28784 + .0349886 \times \left(\frac{\text{5-10 yr}}{\text{10-15 yr}}\right) + .0390881 \times \text{10-15 yr} + .897531 \times \text{5-10 yr}$$

When Y = 0- to 5-year growth.

A value of .806 was obtained for the coefficient of determination ($R^2$) from the multiple regression which suggested an acceptable amount of variation had been accounted for in the independent variables.

It was now desirable that we reconstruct each tree in the growth study to its original size prior to budworm infestation. The diameters could be obtained by subtracting the actual 5-year diameter growth measured by the increment core. The height, however, proved to be more of a problem.

Formulas for predicting height growth based on radial growth are available from the Division of Timber Management and are used in the current Stage II program.

The formula for predicting height 1 year from now is as follows:

$$H + 1 = H + \frac{ASP}{10} + .2464 \frac{H}{D} \left( \frac{(2D-di)(di)}{10(D+D+1)} \right)$$

Where H + 1 = height 1 year from now

H = present height

ASP = constant for each species

di = diameter growth for 10-year period

D+1 = diameter 1 year from now

By rearranging the formula to solve for H where H+1 is known, one should be able to find periodic height growth based on diameter growth for the past 5 years. The formula is as follows:

$$H - 1 + (H-A \div 10) \div (1+.2464) \div D \times \left( \frac{2(D-1)-(d-1)x(d-1)}{10\ (D-1 + D)} \right)$$

Where H-1 = height 1 year ago

H = present height

D-1 = diameter 1 year ago (H-1/5 radial growth 0-5 yr. x 2)

d-1 = 2 x diameter increment based on last 5 years' growth

D = present diameters

Other terms as previously described.

By solving for H-1, one can compute the periodic height growth based on the past 5 years' diameter growth. The height of the tree 5 years ago can now be computed. Predicted heights and diameters for each tree are now calculated using growth rates prior to budworm infestation. Tree volumes are now computed for actual size and predicted size and differences attributed to defoliation impact. Data analysis was made possible by writing special programs on time-share computer facilities available through GSA.

## RESULTS AND DISCUSSION

The results of the survey show that budworm has caused an impact on several host species with grand fir and alpine fir displaying the greatest amount of visible damage. An estimated 13.86 percent of the

Douglas-fir contained top kill. (Table 1.) Western larch had not foliated by the time the survey was completed; therefore, none was shown as being defoliated.

Table 1.--Trees per acre by species and damage class, Valley Creek area, Flathead Indian Reservation, spruce budworm impact survey 1973

| Species | Damage class | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Undefoliated | Defoliated | Top kill | | | | | Total |
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | |
| Ponderosa pine | 5.7 | | | | | | | 5.7 |
| Lodgepole pine | 4.7 | | | | | | | 4.7 |
| Douglas-fir | 12.6 | 176.9 | 28.0 | 0.8 | 1.7 | | | 220.0 |
| Grand-fir | | 20.6 | 34.8 | | 2.9 | 1.1 | 0.5 | 69.5 |
| Alpine fir | | .3 | | | .3 | | | .6 |
| Spruce | .2 | 1.6 | | | | | | 1.8 |
| Larch | 22.8 | | | | | | | 22.8 |

This evaluation showed that considerable damage has occurred over a 5-year period in the area surveyed. Additional surveys are needed to measure losses in other stands to estimate total loss for the Reservation.

Analysis of Douglas-fir trees under 5 inches d.b.h. showed that 55.68 percent had been defoliated by the western spruce budworm and were not suitable for Christmas tree production. (Table 2.)

Table 2.--Impact of western spruce budworm on Douglas-fir under 5" d.b.h. managed for Christmas tree production, Flathead Indian Reservation - 1973

| Damage class | | | | | | | |
|---|---|---|---|---|---|---|---|
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | Total |
| Trees/acre | | | | | | | |
| 134.6 | 157.6 | 11.5 | 0 | 0 | 0 | 0 | 303.8 |

Volume losses per acre from 1967 through 1972 are shown in Table 3. There was a significant growth reduction at the 99 percent level for Douglas-fir, grand fir, alpine fir, and larch. It was possible that some growth loss on larch was caused by the larch casebearer, *Coleophora laricella* Hbn., although the populations have been at a low level in the area for several years. Data from the two nonhost species, ponderosa pine and lodgepole pine, suggested that the actual volume was higher than the predicted volume but was not significant at the 95 percent level. One might expect a slight increase in growth from nonhost species due to decreased competition from suppressed host trees. The results do, however, show a net loss of 19.6 ± 1.9 board feet per acre per year.

Table 3.--Volume of growth loss in the Valley Creek area from 1967 to 1972 caused by western spruce budworm defoliation

| Species | Actual volume | Predicted volume | Difference |
|---|---|---|---|
| | Board feet per acre | | |
| Ponderosa pine | 1,378.0 | 1,374.5 | +3.5 |
| Lodgepole pine | 326.5 | 323.9 | +2.5 |
| Douglas-fir | 3,723.9 | 3,798.0 | -74.2 |
| Grand fir | 311.3 | 324.8 | -13.5 |
| Alpine fir | 42.3 | 44.4 | -2.1 |
| Spruce | 47.0 | 48.0 | -1.0 |
| Larch | 1,500.2 | 1,513.7 | -13.5 |
| | Net loss of | | 98.3 ± 9.5 1/ |
| | or 19.6 ± 1.9 board feet per acre per year | | |
| | Cubic feet per acre | | |
| Ponderosa pine | 318.39 | 317.15 | +1.24 |
| Lodgepole pine | 72.03 | 71.47 | +.56 |
| Douglas-fir | 1,156.08 | 1,179.04 | -22.96 |
| Grand fir | 140.96 | 147.08 | -6.12 |
| Alpine fir | 11.07 | 11.63 | -0.56 |
| Spruce | 9.70 | 9.73 | -0.03 |
| Larch | 328.4 | 331.3 | -2.90 |
| | Net loss of | | 30.77 |
| | or 6.15 cubic feet per acre per year | | |

1/ One standard error.

It was interesting to note that the greatest total volume loss occurred in Douglas-fir. However, an analysis of growth loss by species showed that the greatest impact occurred in true firs when compared on an individual tree basis. Percent volume growth loss for alpine fir and grand fir was 4.815 and 4.161 respectively, whereas Douglas-fir was 1.986 percent. This agrees with previous research data that true firs are most severely affected by budworm defoliation. (Table 4.)

Table 4.--Percent growth loss by tree species, Valley Creek area, Flathead Indian Reservation - 1973

| Species | Percent |
|---|---|
| Ponderosa pine | +0.390 |
| Lodgepole pine | +0.783 |
| Douglas-fir | -1.986 |
| Grand fir | -4.161 |
| Alpine fir | -4.815 |
| Spruce | -0.329 |
| Larch | -0.883 |

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